FORM PTO-1390 (Modified) (REV 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: **PF990063**

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 1.5): **10/088622**

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP00/09256	**20 September 2000 (20.09.00)**	**20 September 1999 (20.09.99)**

TITLE OF INVENTION

METHOD FOR DEVICE REGISTRATION IN A WIRELESS HOME NETWORK

APPLICANT(S) FOR DO/EO/US

Alain Durand, Christophe Laurent, Gilles Straub and Christophe Vincent

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include itens (5), (6), (9) and (24) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☐ is attached hereto (required only if not communicated by the International Bureau).
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☐ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☒ Certificate of Mailing by Express Mail
23. ☒ Other items or information:

Return Postcard Receipt

EXPRESS MAIL LABEL No. EV 025962804US **DATE: March 19, 2002**

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
10/088622	PCT/EP00/09256	PF990063

24. The following fees are submitted:.

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

		CALCULATIONS PTO USE ONLY
☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO	$1040.00	
☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO	$890.00	
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO	$740.00	
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4)	$710.00	
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4)	$100.00	
ENTER APPROPRIATE BASIC FEE AMOUNT =		$890.00
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).		$0.00

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	5 - 20 =	0	x $18.00	$0.00	
Independent claims	1 - 3 =	0	x $84.00	$0.00	
Multiple Dependent Claims **(check if applicable)**.			☐	$0.00	
TOTAL OF ABOVE CALCULATIONS =				$890.00	
☐ Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2.				$0.00	
SUBTOTAL =				$890.00	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +				$0.00	
TOTAL NATIONAL FEE =				$890.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☒				$40.00	
TOTAL FEES ENCLOSED =				$930.00	
				Amount to be: refunded	$
				charged	$

a. ☐ A check in the amount of _____ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. **07-0832** in the amount of **$930.00** to cover the above fees. A duplicate copy of this sheet is enclosed.

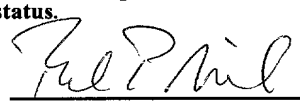
c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **07-0832** A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Mr. Joseph S. Tripoli
Patent Operations
THOMSON multimedia Licensing Inc.
PO Box 5312
Princeton, New Jersey 08540 US



SIGNATURE

PAUL P. KIEL

NAME

40,677

REGISTRATION NUMBER

March 19, 2002

DATE

EXPRESS MAIL LABEL NO. EV025962804US PF990063

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Alain Durand, Christophe Laurent, Gilles Straub, Christophe Vincent

Filed : Herewith

For : METHOD FOR DEVICE REGISTRATION IN A WIRELESS HOME NETWORK

PRELIMINARY AMENDMENT

Hon. Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Sir:

In the US national phase application of PCT/EP00/09256 filed herewith, please enter the following amendments:

IN THE SPECIFICATION:

Please amend the specification as follows:

On Page 1, line 2, please insert the following paragraph:

--This application claims the benefit, under 35 U.S.C. § 365 of International Application PCT/EP00/09256, filed September 20, 2000, which was published in accordance with PCT Article 21(2) on March 29, 2001 in English and which claims the benefit of EP patent application No. 99402299.4 filed September 20, 1999 and EP patent application No. 99119430.9 filed September 30, 1999.—

IN THE CLAIMS:

Please amend Claims 1 and 2 as follows. A marked-up version of the amended claims is attached herewith:

1.(AMENDED) Method for registering a device in a wireless network comprising a central access point wherein it comprises the steps of:

- sending an identification code from the device to the access point;

- checking by said central access point whether the received identification code corresponds to an identification code stored by said central access point and if such checking is positive, sending an authentication key from said access point to said device;

- storage of said authentication key by said device for use in authentication procedures between said device and said access point.

2.(AMENDED) Method according to claim 1, wherein a unique identification code is used within a given network.

IN THE ABSTRACT:

Please add the following Abstract.

-- The invention concerns a method for registering a device in a wireless network comprising a central access point. The method comprises the steps of:

- sending an identification code from the device to the access point;

- checking by said access point whether the received identification code corresponds to the identification code sent by said device and if such checking is positive, sending an authentication key from said access point to said device;

- storage of said authentication key by said device for use in authentication procedures between said device and said access point. The invention is applicable among others in digital home networks. --

REMARKS

The specification has been amended to include a reference to the priority applications.

Claims 1 and 2 have been amended to meet the requirements of the United States Patent and Trademark Office.

To meet the requirements of the United States, the Abstract (as originally filed in the PCT application) is added.

No fee is believed to have been incurred by virtue of this amendment. However if a fee is incurred on the basis of this amendment, please charge such fee against deposit account 07-0832

Respectfully submitted,
Alain Durand
Christophe Laurent
Gilles Straub
Christophe Vincent

Paul P. Kiel
Attorney for Applicant
Registration No. 40,677
609/734-9650

THOMSON multimedia Licensing Inc.
Patent Operation
PO Box 5312
Princeton, NJ 08543-5312

March 19, 2002

MARKED UP VERSION OF THE AMENDED CLAIMS

Please amend Claims 1 and 2 as follows. A marked-up version of the amended claims is attached herewith:

1.(AMENDED) Method for registering a device in a wireless network comprising a central access point [characterized in that] wherein it comprises the steps of:

- sending an identification code from the device to the access point;
- checking by said central access point whether the received identification code corresponds to an identification code stored by said central access point and if such checking is positive, sending an authentication key from said access point to said device;
- storage of said authentication key by said device for use in authentication procedures between said device and said access point.

2.(AMENDED) Method according to claim 1, [characterized in that] wherein a unique identification code is used within a given network.

Method for device registration in a wireless home network

The invention concerns a method for the registration of a device in a wireless home network. The invention can be used in the frame of a network based on the IEEE 1394 – 1995 serial bus standard, but is not necessarily limited to such an environment.

The IEEE 1394 bus is a wired bus, and suffers from inherent drawbacks: it uses a cable, which is a restriction by itself compared to a wireless product, and the cable length between two devices is limited to 4.5 meters. The introduction of wireless transmissions in an IEEE 1394 – 1995 based network is of an obvious interest. This topic is covered by the European ETSI BRAN project that is standardizing a wireless 1394 network in the 5 GHz band, under the title 'Hiperlan type 2'.
Hiperlan 2 is a layered standard defining a PHY layer (OSI level 1), a DLC layer (OSI level 2), and a number of Convergence Layers for some core network technologies (ATM, Ethernet, IEEE 1394...).

Hiperlan 2 proposes a security scheme based on authentication and encryption. This security scheme allows to restrict the access of the network to only allowed users. Hiperlan 2 is initially targeting business applications (corporate LANs), and thus can rely on a certain network management infrastructure. Hiperlan 2 requires for its authentication procedure that both the Mobile Terminal ('MT') and the AP/CC (Access Point – Central Controller) have a shared secret (an 'authentication key') prior to the authentication procedure. This authentication key is communicated to both the MT and the AP during network installation by the network manager.

In a home environment, it is not appropriate to rely on the user to perform such installation operations. The purpose of the present invention is to propose a method using mechanisms already specified in Hiperlan 2 to perform automatic installation of home devices.

The object of the invention is a method for registering a device in a wireless network comprising a central access point characterized in that it comprises the steps of:

- sending an identification code from the device to the access point;
- checking by said central access point whether the received identification code corresponds to an identification code stored by said central access point and if such checking is positive, sending an authentication key from said access point to said device;
- storage of said authentication key by said device for use in authentication procedures between said device and said access point.

According to a preferred embodiment, a unique identification code is used within a given network.

Further characteristics and advantages of the invention will appear through the description of a preferred, non-limiting embodiment of the invention. This embodiment will be described with the help of the following figures, which are an integral part of the present description:

- Figure 1 is a schematic diagram of a network comprising two wired buses communicating through a wireless link.
- Figure 2 is a high-level message sequence chart illustrating the messages exchanged between a Mobile Terminal and an Access Point for creating an association according to the present embodiment.
- Figure 3 is a message sequence chart defining the messages exchanged between different layers of the MT and AP during one of the phases (Information Transfer) defined by the chart of figure 2.
- Figure 4a, 4b and 4c respectively represent a Convergence Layer Information Container for containing Information Elements, and two Information Elements used during the message exchanges of the chart of figure 3.
- Figure 5 is a message sequence chart defining the messages exchanged by the MT and the AP during the authentication phase of the chart of figure 2.
- Figure 6 is a schematic diagram of the association process of the terminal and the central controller.
- Figure 7 is a schematic diagram of the authentication phase between the central controller and the terminal.

- Figure 8 is a schematic diagram of the key download phase from the central controller to the terminal.

The present embodiment is placed in the frame of BRAN/Hiperlan 2. More information concerning this environment can be found in the following document Broadband Radio Access Networks HIPERLAN Type 2 Functional Specification Data Link Control (DLC) layer parts 1 and 2 (DTS/BRAN030003-1) and associated documents among which the document DTS/BRAN-002004-2 concerning the Radio Link Control (RLC) sublayer.

Figure 1 is a diagram of a network comprising an Access Point (AP) 1 and a Mobile Terminal (MT) 2, respectively connected to wired IEEE 1394 busses 3 and 4. The AP and the MT form a wireless link between the two wired busses. It is assumed in what follows that the AP (or Central controller CC) is a function that may be implemented in any device. There shall be no prerequisite that there is one fixed AP/CC device in the home network, but rather that one Central Controller is selected among a number of devices having such a capability.

Before a MT and the AP can associate, a preliminary key negotiation phase must take place in order to generate a symmetric encryption key. This negotiation is based on the Diffie-Hellman (DH) algorithm. The general mechanism of this algorithm is the following:

1. The MT and the AP have agreed on a base generator g and a large prime number n;
2. Both of them generate a random number called the Diffie-Hellman private value. Suppose that the MT generates the number x and the AP generates the number y;
3. The MT computes its DH public value $MT\_DH\_PV=g^x \bmod n$ and sends it to the AP;
4. The AP computes its DH public value $AP\_DH\_PV=g^y \bmod n$ and sends it to the MT.
5. The MT computes $k=AP\_DH\_PV^x \bmod n$;
6. The AP computes $k'=MT\_DH\_PV^y \bmod n$.

After this process, the AP and the MT can compute the shared secret session key since $k=k'=g^{xy} \bmod n$. For this purpose this key, called Session Secret Key or 'SSK', is computed by:

$SSK=HMAC\text{-}MD5(g^{xy} \bmod n,0)$

With :

$HMAC\text{-}MD5(k,m)=MD5((k \text{ XOR } opad)|MD5((k \text{ XOR } ipad) | m))$

Where :

- k is a secret key;
- m is the message;
- ipad is 0x36 repeated 64 times;
- opad is 0x5c repeated 64 times;
- XOR is exclusive OR;
- | is the concatenation operator.

Note that if someone eavesdrops on the communication between the MT and the AP, he only learns *n*, *g*, *MT_DH_PV* and *AP_DH_PV*. Thus, he cannot deduce the value of the key *k* since he does not know the secret random numbers *x* and *y*.

Once the SSK key is generated, the authentication phase can take place. This phase allows the MT to be authenticated by the AP and allows the AP to be authenticated by the MT.

In Hiperlan 2, this step is based on a challenge-response approach :

- The MT sends its identifier to the AP, encrypted with the just negotiated SSK encryption key;
- The AP then sends a challenge (that is a random number) C_{AP} to the MT;
- The MT proves its identity by responding to the challenge C_{AP}. For this purpose, it "signs" the challenge either with a secret key shared with the AP or with its private key when a PKI (*Public Key Infrastructure*) is used. The MT sends its response $R(C_{AP})$ as well as a new challenge C_{MT} to the AP;
- The AP verifies the response $R(C_{AP})$, "signs" the challenge C_{MT} in order to prove its identity and sends back its response $R(C_{MT})$ to the AP;
- The MT verifies the response $R(C_{MT})$.

If the responses $R(C_{AP})$ and $R(C_{MT})$ are correct, both MT and AP are thus authenticated since they proved they know a secret.

In a business environment the authentication would be configured by a network administrator. For a home environment, a more automatic authentication procedure is desirable. The interface with the user should be as simple as possible. The 1394 bus per se has "*plug and play*" capabilities, so it is desirable to extend this capability to the wireless network.

A MT wanting to associate with a network needs an authentication key that shall be known by the Central Controller. This authentication key is used during the association phase, via a challenge / response mechanism, in a way similar to that given above. It has been proposed that a single common key be used for the whole network, and that this key be based on the GUID of the first Central Controller registered in the network.

More specifically, before using a wireless device, an installation phase will be necessary. This phase consists in giving the authentication key of the network to the new MT. According to the present embodiment, this value transfer is secured by a code such as a PIN code to prevent any neighbor from obtaining this key.
It is proposed to use a same PIN code on all the devices for device installation. This PIN code is entered by the user and exchanged over the air interface. It is checked by the CC, that can then communicate the authentication key. The authentication key shall then be stored by the MTs (on non volatile memory), and it will be used at any power on phase to carry out the authentication process.

This method focuses on devices that provide enough user interaction capabilities for entering the PIN code. Typically, such a device comprises a display and a number of keys. The device may provide an installation menu that the user has to select. Upon activation of the installation menu, the device erases any previously stored authentication key. Such devices may also be much simpler. User input may be reduced to the setting of micro-switches.

If the device is a CC capable device, then the device shall further ask the user:

*A/ do you want to install a new network?

*B/ do you want to install a device on an existing network?

If the device is not a CC capable device, then there is no need for this submenu since the user can obviously only connect this device to an existing network.

If the user answers « A », then the device asks for a PIN code. This PIN code will be valid for the whole network. The device then builds an authentication key by concatenating its own GUID and the entered PIN code. The PIN code is stored in non volatile memory to be retrieved at each power on. The device can then start CC operation (i.e. act as an HL2 Access Point), waiting for further devices.
The GUID is a 64-bit quantity used to uniquely identify an IEEE 1394 device. It consists of a 24-bit company ID (obtained from the 1394 Registration Authority Committee) and a 40-bit serial number assigned by the device manufacturer. The GUID is stored in a device's configuration ROM and is persistent over 1394 network resets.
Other types of identifiers may also be used, as long as it is made sure that no two devices in the network have the same identifier.

If the user answers « B », then the device asks for a PIN code (that shall be the whole network PIN code which the user already initialized on the first installed device). The device then starts MT operation. The MT scans the spectrum, and looks for a beacon under the form of a BRAN frame header. When it finds such a beacon, and after SSK determination, using Link_Info messages, it sends the user entered PIN code to the CC. The user entered PIN code shall be encrypted using the Diffie Hellman session key (the RLC messages are not encrypted). The CC can then check whether the received PIN code (from the air interface) is the same as the one it already has. If the check is successful, then a positive answer is sent through the RLC_INFO_ACK message, with the authentication key (the authentication key is also encrypted using the Diffie-Hellman session key). Otherwise a denial is sent in the RLC_INFO_ACK. More details of the exchange are given in figure 3.

Once the MT has received the authentication key, the installation phase is over. The MT shall store the key in a non-volatile memory. It could also store the NET_ID (contained in a field of the BCCH) that can help in further frequency

scanning. The NET_ID does not uniquely identify a network, but can simplify the frequency scanning and avoid useless authentication tentatives.
It can then further run the power-on, or booting, procedure (see below). If the device does not get the authentication key, it shall look for another frequency, and thus for another CC and try again.

According to the present example, the PIN code and the authentication key are part of the CL_Info container, and thus described for each convergence layer. Another possibility is to make it part of the DLC layer container since it contains data that is relevant to the DLC layer.

Figure 4a represents the convergence layer information container's format (CL_layer_container). It contains several Information Elements (IEs). Figures 4b and 4c represent the formats of two IEs which are needed for the protocol, namely the PIN code IE and the Authentication key IE, and contained in the convergence layer container. The variable 'Authentication_key) is equal to the concatenation of the GUID of the first installed GUID and the PIN code.

The procedure at power on is illustrated by figure 2: A MT only device searches for the beacon by scanning the available frequencies. If it previously stored a network identifier (Net_ID), it first searches for the BCCH field containing this identifier. Once the BCCH is found, encryption and authentication steps are carried out. If the BCCH with the correct Net_ID is not found, CCs with other identifiers may be searched for.

No specific parameter is needed in the RLC_Authentication message (since a single key is used). The authentication key (GUID + PIN code) is used by the MT to compute the challenge response sent in the RLC_Authentication_AP message. The same authentication key (GUID + PIN code) is used by the AP/CC to check whether the device is allowed or not (whether it shares the same key), and thus to generate the response.
If the MT is authenticated, then it can complete the association phase and join the network. Otherwise it tries on another CC.
Figure 5 describes the message exchange of the authentication procedure.

The described method may be extended to multiple authentication keys.

The major drawback of the present approach appears when a device is to be uninstalled: when the user wants to remove only part of his devices (at least one stolen device), he has to change the pin code, and to reinstall all his wireless devices.

This drawback disappears when one authentication key is used for each device. The same procedures and message sets can be used for a multiple authentication key network with the following modifications:

- Installation phase:

During installation, the MT has to send its GUID to the CC. The MT GUID concatenated to the PIN code is the MT authentication key. The authentication_key IE can be used (or even a new information element can be defined, without the Accept/denied flag), and can be carried in the RLC_INFO message. The Authentication key sent in the RLC_INFO message has to be encrypted using the Diffie-Hellman session key.

The PIN code is used by the CC to check whether the MT is allowed to be installed. If the PIN code test matches, then the authentication key of the MT is stored by the CC in non volatile memory.

The RLC_INFO_ACK in that case just contains the accept/denied flag. No authentication key is needed.

- Power on phase:

During Authentication phase, the RLC_Authentication message sent by the MT to the CC shall contain the authentication ID of the MT (which is the GUID of the MT). Then the authentication key to be used for the challenge / response exchange shall be the MT GUID concatenated to the PIN code.

This approach allows a user to remove one device without needing to reinstall his complete network.

The invention has several advantages. User involvement is reduced to just entering a PIN code during device installation. Also, the PIN code provides a good level of security for device installation and guarantees that devices are wirelessly installed to the appropriate network

The first embodiment concerns the implementation within the context of BRAN HIPERLAN 2. The second embodiment, which will now be described, takes a more general approach, and describes a more secure way of transmitting information from the MT to the CC.

In this embodiment, we propose a solution to secure the registration of a new terminal in an existing network. This network handles two types of device:

1. General purpose devices (camcorder, television, phone, tape recorder, PC, etc.) called *terminal* in the document;
2. A special device which acts as a central server and that is called *Central Controller* (CC) in this document. Note that there is only one CC in the network at the same time.

We suppose that all communications between a terminal and the CC may be secured with the use of cryptographic tools. A terminal can communicate with the CC once the *association phase* has been executed. This phase is shown in Figure 6.

As shown in Figure 6, and as in the first embodiment, the association phase has two steps:

1. In *DH Key Exchange* step, the terminal and the CC generate a session key (called *SSK*) that will be used to secure all messages exchanged between the terminal and the CC. This key creation uses the Diffie-Hellman protocol previously described.

2. In the *mutual authentication* step, both devices are mutually authenticated in order to be sure each is valid (e.g. not a hacked device).

This second step can be based on a challenge-response approach that proves that each actor knows a secret (i.e. the authentication key) that is shared by all devices in the network. As shown in Figure 7, this scheme has three steps :

1. The CC sends to the terminal a random number, called challenge, *C1*;

2. The terminal responds by applying a function *F* to the challenge. The result depends on the challenge and on the secret authentication key *K* shard by the terminal and the CC (*F* can be a Message Authentication Code – or MAC- for example). In the same message, the terminal sends to the CC a new challenge *C2*;

3. The CC verifies the response given by the terminal and responds to the challenge *C2* by applying the function *F*. The terminal verifies the response given by the CC.
At the end of this authentication, both parties are mutually authenticated.

In this scheme, a terminal must know the shared secret *K* to be authenticated. Therefore, when a user buys a new terminal, this shared secret must be stored in the terminal before any use. However, this secret is different in each network and thus, this phase must be made dynamically on each network.
According to the present embodiment, it proposed to secure the registration scheme that downloads the shared secret key *K* in a new terminal. This scheme must be secured to avoid that anyone can register his terminal in another one's network. For example in a home network environment, a user certainly does not want his neighbor to spy on him.

The following notations are used:
"$E_K(M)$" denotes the encryption of a message *M* with the symmetric key *K*;
"|" denotes the concatenation operator.

More information concerning cryptography may be found in the book: **Bruce Schneier**, "*Applied Cryptography*", Wiley Publisher, 1996, second edition.

The proposed solution downloads the secret key *K* into a device. A PIN code (i.e. an identifier) is used to identify each network. The PIN code is stored in the CC.

Two scenarios are presented:1. The device is the first device installed in the network;2. The device is a new device in the network.

In the first case, the secret key *K* must be generated by the device (which acts therefore as the CC) whereas in the second case, the secret must be sent by the existing CC to the new installed device.

In the first case, the device acts as the CC and must generate the secret key *K*. It can be the output of a random generator, or the result of a function *f* that depends on several parameters such as the device identifier, the network PIN and eventually other parameters:

$$K=f(device\_id, PIN, ...).$$

Once the PIN is generated, it may be checked that it is not used by another close network in order to ensure the registration of the terminal on the right network.

In the second case, when a new device is installed in the network, it must know the secret *K* before the authentication phase (see Figure 7) can take place. The key download is executed just after the "DH Key Exchange" phase where a terminal and the CC exchange the secret session key SSK (see Figure 6). Figure 8 illustrates this key download.

The key download phase has two steps:

1. The terminal requests the network PIN from the user (the terminal must have a way to perform this task). Then, the terminal computes the result of a function *g* using the PIN and other parameters such as the terminal identifier. The computed value is then encrypted eventually with other parameters using the key SSK. The result is sent to the CC. The input parameters of function *g* should present some redundancy with those involved in the encryption.
2. The CC recovers the message, checks the redundancy and retrieves the entered PIN. If the PIN corresponds to the stored network PIN, then the CC sends the secret *K*, encrypted with the key SSK, to the new terminal. Once the terminal has decrypted *K*, it stores it into a secure memory and can now terminate the association phase.

The security aspects of the proposed solution will now be described. The terminal can be installed only if the user knows the network PIN. However, a

PIN is generally composed of four digits. Thus the solution should prevent from a brute force attack. This attack is made difficult by the use of the function g (which is different from the base generator of the same name of the description of the DH algorithm given in the first embodiment). For this function g, two cases are possible:

1. This function is kept secret;
2. This function is known.

Note that both cases impose the user to enter by hand the PIN on the new installed terminal. Therefore, we can limit the number of PIN trials on the terminal itself.

The case when g is a secret function will now be described. An attacker cannot develop a software that automatically scans all possible PINs since he does not know the function *g*. Therefore, he must enter manually all possible PINs if he wants to crack the system. The use of the device identifier as parameter of the function would allow to detect successive unsuccessful attempts by the CC. The CC could manage a list of malicious terminals.
In this case, the security of the system depends on the PIN and on the function *g*.

The case when g is a known function will now be described. Thus a secret must be added to prevent from a brute force attack. All devices share a global secret key denoted by GSK. For example, this key can be kept secret by an authority which inserts it in all devices before sale.
Now, the function *g* can be defined as follows:

$$g=E_{GSK}(PIN|Terminal\_id|r)$$

Where *r* denotes a random number generated by the terminal.
Then, the message sent is:

$$E_{SSK}(E_{GSK}(PIN|Terminal\_id|r)|r).$$

When the CC receives this message, it performs the following steps:

1. It decrypts the message by using the key SSK and retrieves the random number *r*;
2. It decrypts the first part of the previous decrypted message to retrieve the message *PIN|Terminal_id|r*. Then, it tests if the *r* value decrypted in step 1 and the *r* value decrypted in the present step match. Unmatched values mean that an attacker tries to crack the system and thus the CC can enter in a blocked state.

In this case, the security of the system depends on the key GSK and on the use of the random number *r*. Indeed, if an attacker tries to crack the system without knowing the global key GSK, it cannot generate the message $E_{GSK}(PIN|Terminal\_id|r)$. Therefore, the CC cannot retrieve the same random number values and thus, the system is blocked at the first hacking attempt. However, if the user enters a bad PIN on a valid device, the system does not block since the message $E_{GSK}(PIN|Terminal\_id|r)$ is well formed.

GLOSSARY

ACF	Association Control Function
AP	Access Point
BCCH	Broadcast Control CHannel
CC	Central Controller
CL	Convergence Layer
DLC	Data Link Control Layer
DH	Diffie-Hellman
ENV	Environment Layer (Convergence Layer)
GSK	Global Secret Key
GUID	Global Unique Identifier
MAC	Medium Access Control (1st embodiment) or Message Authentication Code (2nd embodiment)
NET_ID	Network Identifier
PHY	Physical Layer
PIN	Personal Identification Number
RLC	Radio Link Control Protocol
SSK	Session Secret Key (1st embodiment) or Shared Secret Key (2nd embodiment)

CLAIMS

1. Method for registering a device in a wireless network comprising a central access point characterized in that it comprises the steps of:
- sending an identification code from the device to the access point;
- checking by said central access point whether the received identification code corresponds to an identification code stored by said central access point and if such checking is positive, sending an authentication key from said access point to said device;
- storage of said authentication key by said device for use in authentication procedures between said device and said access point.

2. Method according to claim 1, characterized in that a unique identification code is used within a given network.

3. Method according to claim 1, wherein said authentication key is unique for the network.

4. Method according to claim 1, wherein said authentication key is specific to each device.

5. Method according to claim 1, wherein said identification code is transmitted to the access point using a secret session key and a further function known by both the device and the access point.

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(71) Applicant *(for all designated States except US)*: **THOMSON MULTIMEDIA** [FR/FR]; 46, quai Alphonse Le Gallo, F-92100 Boulogne-Billancourt (FR).

(72) Inventors; and

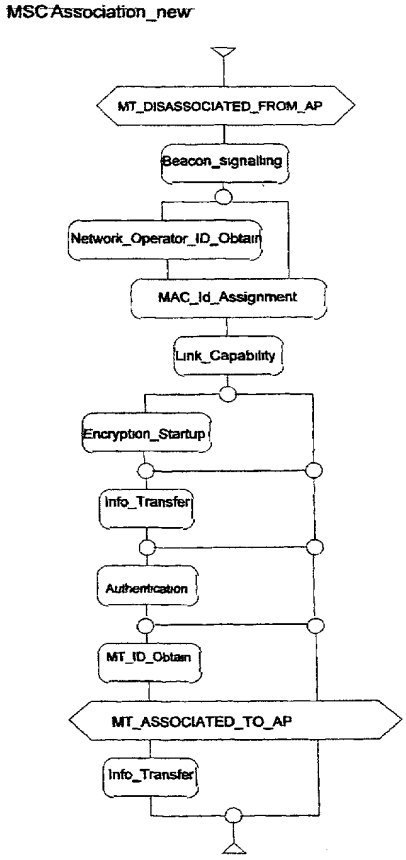
(75) Inventors/Applicants *(for US only)*: **STRAUB, Gilles** [FR/FR]; Thomson Multimedia, 46, quai Alphonse Le Gallo, F-92648 Boulogne Cedex (FR). **LAURENT, Christophe** [FR/FR]; Thomson Multimedia, 46, quai Alphonse Le Gallo, F-92648 Boulogne Cedex (FR). **VINCENT, Christophe** [FR/FR]; Thomson Multimedia, 46, quai Alphonse Le Gallo, F-92648 Boulogne Cedex (FR). **DURAND, Alain** [FR/FR]; Thomson Multimedia, 46, quai Alphonse Le Gallo, F-92648 Boulogne Cedex (FR).

(74) Agent: **KOHRS, Martin**; Thomson Multimedia, 46, quai Alphonse Le Gallo, F-92648 Boulogne Cedex (FR).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ,

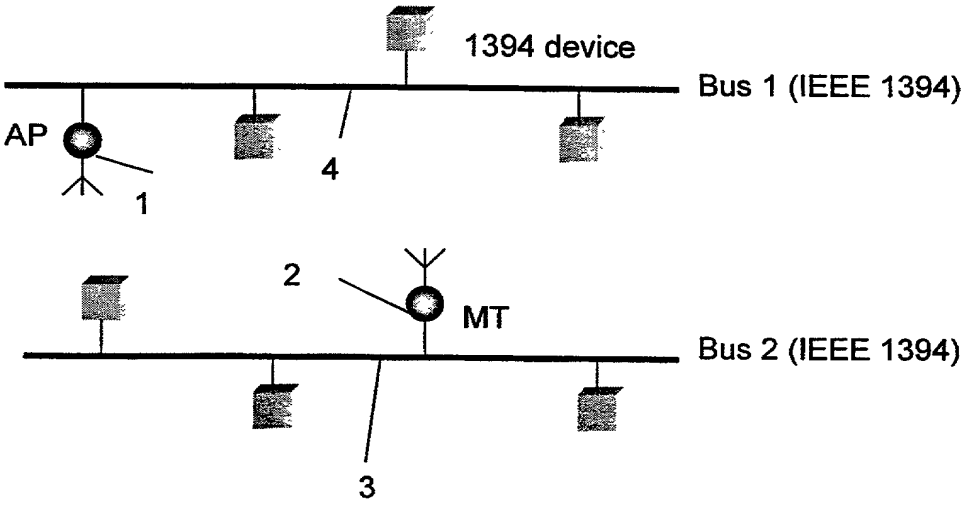
[Continued on next page]

(54) Title: METHOD FOR DEVICE REGISTRATION IN A WIRELESS HOME NETWORK



(57) Abstract: The invention concerns a method for registering a device in a wireless network comprising a central access point. The method comprises the steps of: sending an identification code from the device to the access point; checking by said access point whether the received identification code corresponds to the identification code sent by said device and if such checking is positive, sending an authentication key from said access point to said device; storage of said authentication key by said device for use in authentication procedures between said device and said access point. The invention is applicable among others in digital home networks.

WO 01/22661 A3



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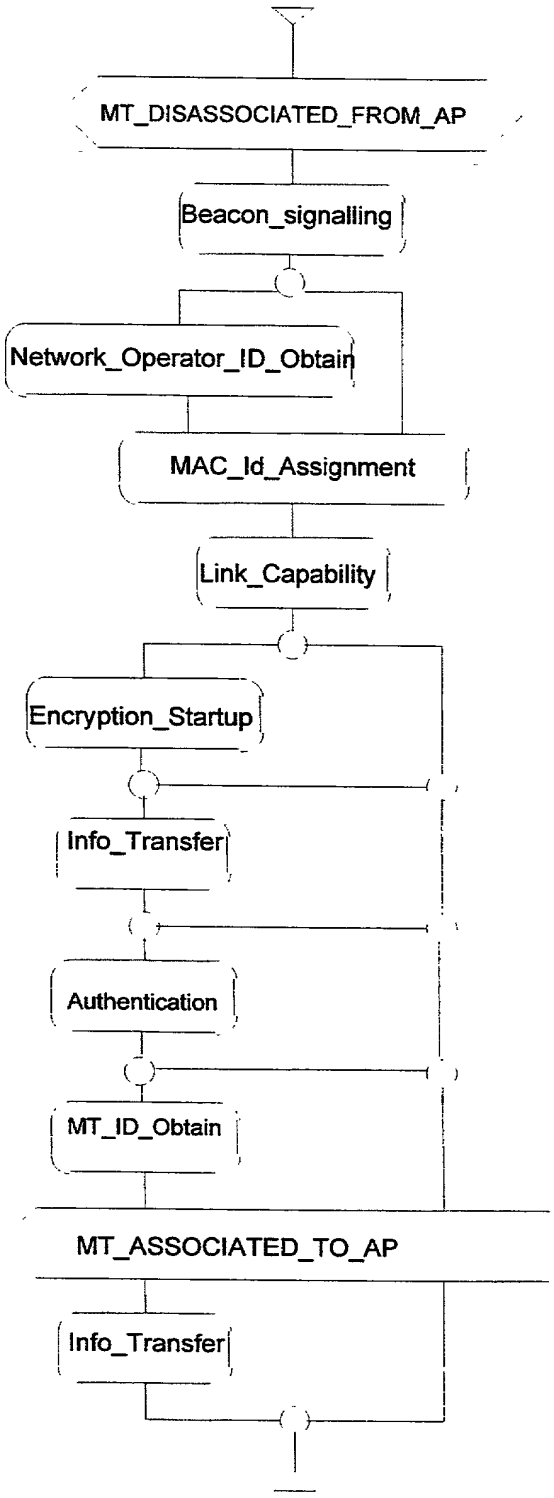
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Info_Transfer
Authentication
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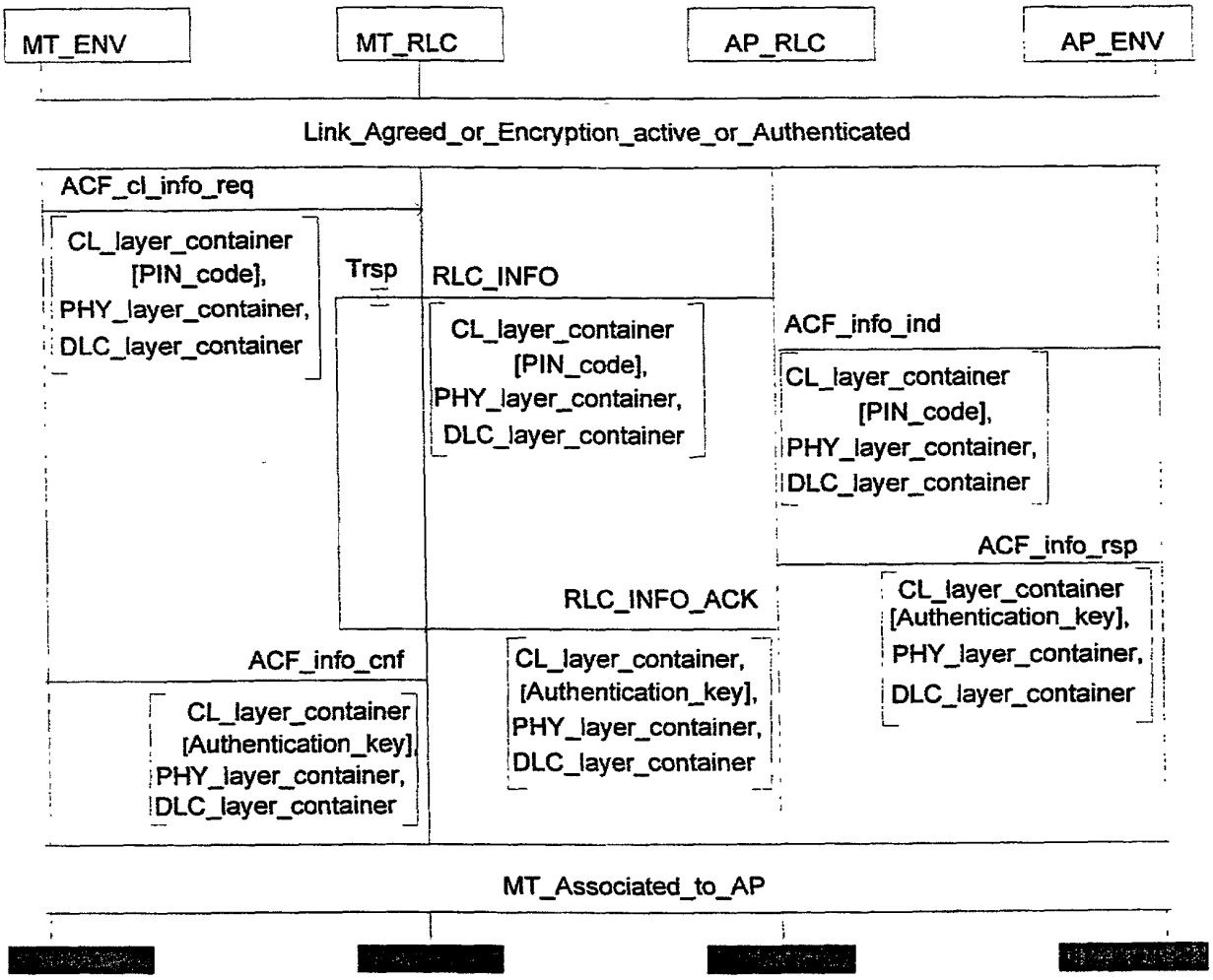
Info_Transfer

Fig. 2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MT_Associated_to_AP

Fig. 3

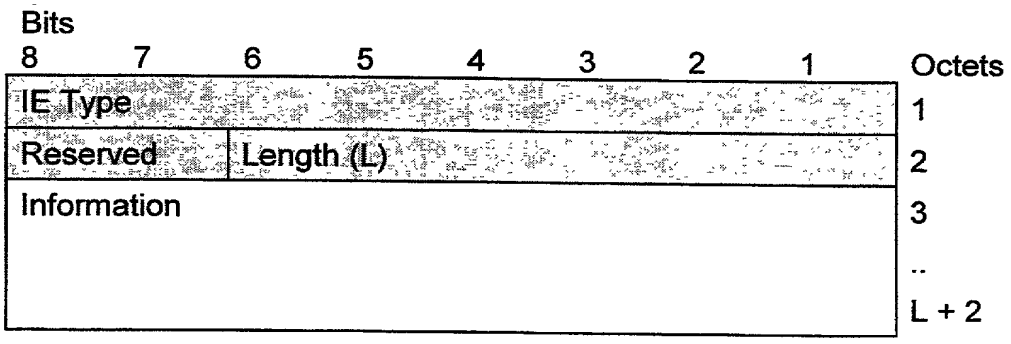

Fig. 4a

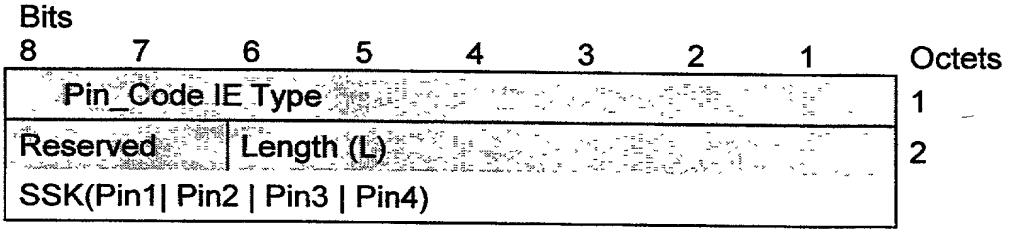

Fig. 4b

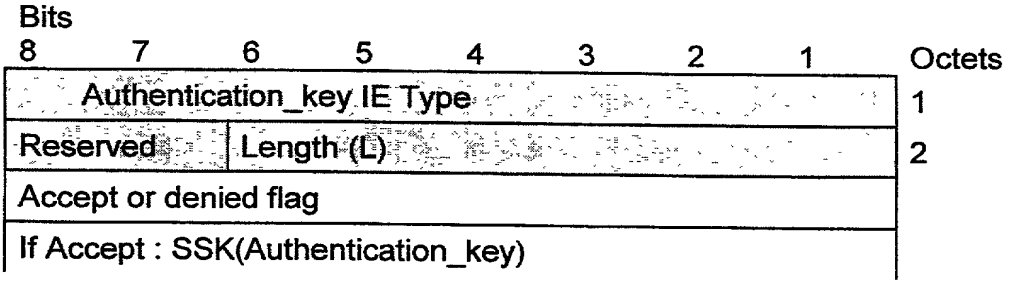

Fig. 4c

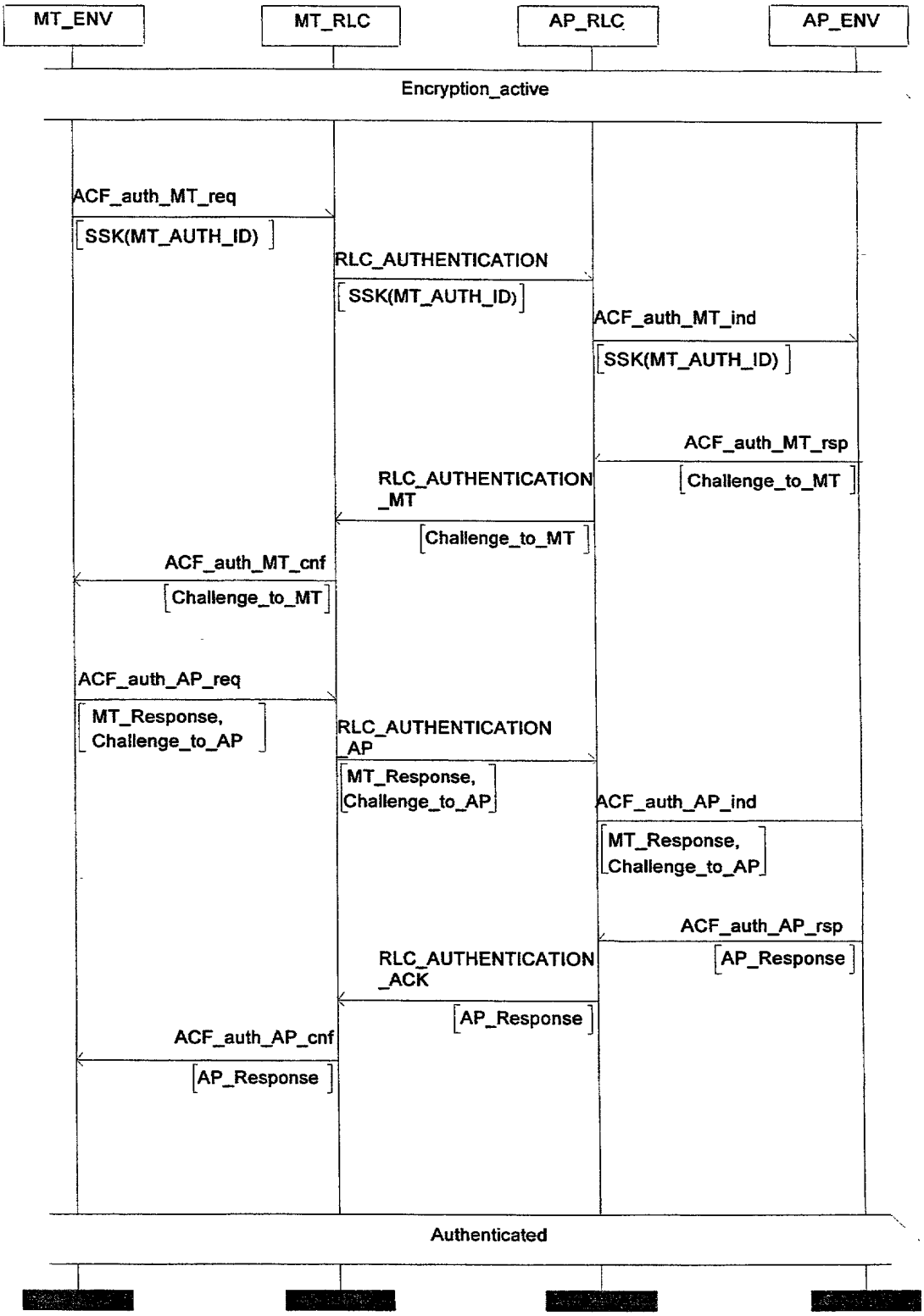
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Fig. 5

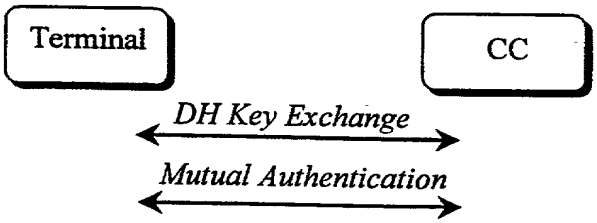

Fig. 6

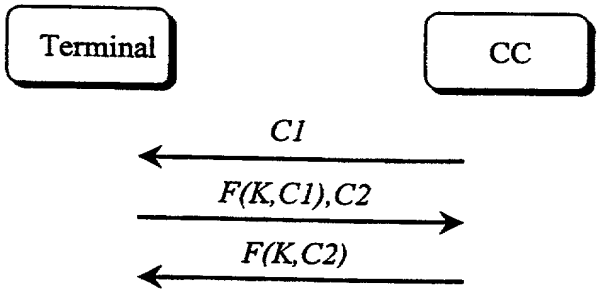

Fig. 7

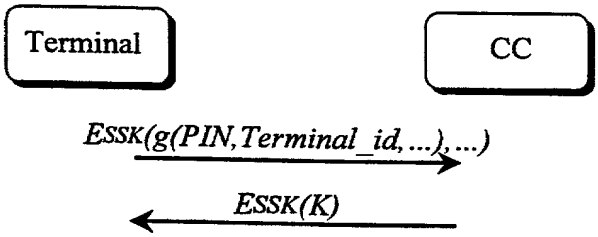

Fig. 8

EXPRESS MAIL EV025962804US

DECLARATION FOR UNITED STATES PATENT APPLICATION,
POWER OF ATTORNEY, DESIGNATION OF CORRESPONDENCE ADDRESS

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name, and that I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Method for device registration in a wireless home network

the specification of which
(CHECK ONE) ( ) is attached hereto.
(XX) was filed on September 20, 2000, Application Serial. No.PCT/EP00/09256 and was amended on .

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with 37 CFR 1.56(a).

I hereby claim foreign priority benefits under 35 USC 119 of any foreign application(s) for patent, utility model, design or inventor's certificate having a filing date before that of the application(s) on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed	
Number	Country	Date Filed	Yes	No
99402299.4	EP	September 20, 1999	xx	
99119430.9	EP	September 30, 1999	xx	

I hereby claim the benefit under 35 USC 120 of any US Application(s) listed below, and, insofar as the subject matter of each of the claims of this Application is not disclosed in the prior US application in the manner provided by the first paragraph of 35 USC 112, I acknowledge the duty to disclose information which is material to the examination of this application in accordance with 37 CFR 1.56(a).

Serial No.: Filed.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that wilful false statements and the like so made are punishable by fine or imprisonment, or both, under of 18 USC 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

I hereby appoint the following attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: Joseph S. Tripoli (Reg. No. 26,040), Dennis H. Irlbeck (Reg. No. 26,372), Eric Herrmann (Reg. No. 29,169) and Joseph J. Laks (Reg. No. 27,914) Telephone: (609) 734-9813.

Address all correspondence to Joseph S. Tripoli, Patent Operations - Thomson multimedia Licensing, Inc. - CN 5312 - Princeton, New Jersey 08543-0028.

4

1-00

Signature: _____ Date: 11 day of March ,2002.
Sole or First Joint Inventor: Alain DURAND
Citizenship: FR
Residence and Post Office Address: 79 rue de Dinan
F-35000 Rennes
France FRX

Signature: _____ Date: _____ day of _____ ,2002.
Sole or First Joint Inventor: Christophe LAURENT
Citizenship: FR
Residence and Post Office Address: 3 rue des Fraîches
F-35630 Vignoc
France

DECLARATION FOR UNITED STATES PATENT APPLICATION,
POWER OF ATTORNEY, DESIGNATION OF CORRESPONDENCE ADDRESS

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name, and that I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

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Signature: _____ Date: _____day of_____,2002.
Sole or First Joint Inventor: Alain DURAND
Citizenship: FR
Residence and Post Office Address: 79 rue de Dinan
F-35000 Rennes
France

2-00

Signature: _____ Date: 11 day of March ,2002.
Sole or First Joint Inventor: Christophe LAURENT
Citizenship: FR
Residence and Post Office Address: 3 rue des Fraîches
F-35630 Vignoc
France

FRX

3-00

Signature: ________________ Date: 12 day of March, 2002.
Sole or First Joint Inventor: Gilles STRAUB
Citizenship: FR
Residence and Post Office Address: Grèbusson
F-35690 Acigné
France

FRX

4-00

Signature: ________________ Date: 11 day of march, 2002
Sole or First Joint Inventor: Christophe VINCENT
Citizenship: FR
Residence and Post Office Address: 7 rue des Landes
F-35490 Gahard
France

FRX